Table 2: Data Networks

				Leo One Internal Research		MTA-EMCI Study		Economic Analysis
	Description	Target Markets	Geographic Coverage	Cost of Subscriber Equip.	Cost of Service	Cost of Subscriber Equip.	Cost of Service	Relative Cost Measure
Broadband PCS	Digital networks being built in majo markets based on a cellular typ architecture	Designed primarily for voice, but dat will also be available. A "paging" typ service will be offered in firs generation handsets	Very limited.	$200+	$0.15 - $0.30 pe minute. Roamin unavailable	$200 - 600	$12 per mont (est.) average dat usag	L
Analog SMR	Trunked radio networks built primarily fo voice communications	Trucking, dispatch	Major markets.	$395	$20 - $30 pe mont	$500-1000 $300-500 fo mode	$7.50 per mont (est.) attributed t dat	L
GeoTek Communications	Spread spectrum system using SM frequencie	Dispatch/scheduling, automate vehicle location, messaging, credi card transaction	Eventually in 36 metropolitan areas			$800 - 1200	$10 - $20 pe mont	M
NexTel	Integrated digital voice and data networ built with frequency reuse	Trucking, dispatch, users that nee integrated voice/data, cellula replacemen	Some major markets.	$600-700	$60 per month.	$600-1200	$65 per mont ($13/mo. for data	M
Terestrial Data								
Ram Mobile Data	Network owned by BellSouth designed t deliver packet data over SM frequencies	Point-of-sale applications, messagin to mobile workers, dispatc	Covers 92% of the US urba population. Has plans to offe customers access t complementary networks (cellular satellite, or CDPD)	$500-600 fo Mobile modem	$25 - $135 pe month dependin on usage	$795	$55 - $65 pe month ave	M
Ardis	Network owned by Motorola designed t deliver packet dat	Point-of-sale applications, messagin to mobile workers, dispatc	Same general coverage as Ra Mobile Data	$500-$600	$25-$135 pe month dependin on usage	$600	$70 per mont ave	M
CellNet	Network designed around a cellular typ architecture but limited to dat	Current focus is on meter reading, bu has plans for monitoring of vendin machines, residential security, etc	Networks built specifically fo untilities with which they hav contracts	unknown	unknown	n/a	n/a	L
Metricom	Mesh network architecture operating o frequencies in an unlicensed ban	Meter reading and SCAD applications for utilities, messagin and internet access	Primarily covers selected academi and corporate "campuses". Som metropolitan rollouts beginning	$150-300	$15-25 per mont for messaging an internet acces	$500	$30 per month	L
CDPD	Packet data network overlay for analo cellular systems	Messaging, file transfer, mete reading, SCADA, telemetry, dispatc	Currently in commercial service o test in 110 markets	$600 fo CDP modem	$0.036 to $0.12 pe kilobyte dependin upon the servic pla	$600	$0.3-$0.12 pe kilobyte - Average Credit car verification $11/mo. Messaging $55/mo.; Alar polling - $14/mo	M
Cellemetry	Technology developed by BellSouth t transmit small data messages using th control channel of analog cellular system	Vending machine monitoring, mete reading, security system monitorin	Currently being tested in severa markets. Very limited commercia availability	$100	$5 per month fo alarm monitoring $10 for shor messagin	n/a	n/a	I
Pinpoint Communications	Network providing high speed dat through patented ARRAY technolog	Fleet management, tracking messaging, and file transfer	First phase includes 2 metropolitan area			$300	$15 per month	I
Nexus Telecommunications	Digital spread spectrum system operatin in the ISM ban	Vending machines, remote securit monitoring, meter readin	Currently being tested.			n/a	n/a	I
Narrowband PCS	Skytel has the only two-way system, wit limited return path capabilities. Others wil be built (Mobilecomm, PageNet, etc.	Messaging, SCADA, Telemetry	Major markets.	$250	$40-60 per month.	$200 - 400	$30 per month (tw way paging	I
AirTouch Teletrac	Data network built in ISM band	Mobile data and vehicle location	6 metropolitan markets			$500	$32 per month	L

2: Data Networks, along with Leo One USA management's analysis of their target markets and geographic coverage. Once a market segment is determined to have one or more data networks technically capable of addressing the service requirements we further differentiate between providers based on service cost to the customer.

As Table 1 indicates, there are a number of markets in which Little LEOs will face competitive alternatives in the form of Big LEO systems, GEO systems or terrestrial systems.[9] Effective participants in a market are those whose costs are low enough that they could be expected to be able to survive in a market where competing Little LEO systems had driven prices down to competitive levels in a Little LEO market. From the data in Table 2, we identify individual suppliers (or types of suppliers, such as broadband PCS that may include multiple individual suppliers) with costs of equipment of less than $ 500, and monthly service charges of less than $ 30.[10] Such suppliers are designated with an "L" in Table 1 for "low cost". Firms which would be likely to be able to enter and remain in the market only at prices significantly above that level, but still below the level that a Little LEO that had a monopoly in that market would choose to set, (identified from Table 2, using the criteria that cost of equipment be between $ 500 and $ 1000, and cost of service between $ 50 and $ 80) are designated with an "M" for "medium cost". Even if such firms do not enter the market, their presence on the wings may constrain pricing by a Little LEO monopolist. Firms which enter and remain in the market only at prices above those levels --- levels likely to be what a Little LEO firm that was the only supplier of Little LEO services in that market would find profit maximizing -- are denoted by an "H" for high cost. Their presence would not be likely to deter even monopoly pricing by a Little LEO firm that was the only supplier in that market.

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[9] Table 2 may well not have captured every provider in the urban pockets of coverage, but enough are represented to conclude that the market is competitive and therefore the inclusion of any additional firms would not change the results.

[10] The Data Network Table contains information from both Leo One's analysis and from a recent study by MTA-EMCI, "The US Mobile Data Market: 1995."

In addition to describing a market participant by its relative cost we indicate the status of the service provider, by denoting with a capital letter L, M, or H, those systems in which a customer could purchase service today. Systems that are planned but are not in widespread operation with service available to customers today are identified with a small letter l, m, or h, as appropriate.

In identifying participants in a market, it is important, however, not to include producers of complements as opposed to substitutes. For example, while both steel firms and iron ore firms might be described as being in the steel business or at least in related businesses, steel production and iron ore production are complements, not substitutes. Steel and iron ore are therefore in different markets, and a firm that was the only producer of steel would still be a monopolist in the steel market even if there were hundreds of iron ore firms. Stated differently, a competitive iron ore industry would not constrain prices -- and indeed would encourage even higher prices -- charged by a steel monopolist. A more complex example that is more similar to this case is provided by cellular and wireline services, which are generally regarded as essentially complementary. Even a large increase in wireline prices would not induce large numbers of customers to switch to exclusively cellular service. In addition, cellular prices that are much higher than wireline can be maintained because cellular essentially fills in a gap in wireline service. Thus even if, at some low enough price, cellular could be a close substitute for wireline, wireline would not be a close substitute for cellular even at a very high price for cellular.

Similarly, in many of the markets identified in Table 1, the services provided by a Little LEO supplier are more likely to be a complement than a substitute for several of the services provided by other (non-Little LEO) suppliers. [11] In the nationwide, non-ubiquitous truck dispatch

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[11] For example, ORBCOMM's Offering Memorandum (ORBCOMM Global, L.P. (and) ORBCOMM Global Capital Corp., *Offering Memorandum*, Bear, Stearns & Co. Inc. *et. al.*, August 2, 1996, hereinafter referred to as "ORBCOMM") states that :

> The company expects that in the United States, The ORBCOMM system will complement existing and planned terrestrial wireless communications systems, by

and monitoring tracking market, for example, Ram Mobile Data and Ardis may be sufficiently low cost to compete effectively with a Little LEO system, and even exclude Little LEO services from some (*e.g.*, urban) markets entirely, but their coverage is limited to urban areas. Customers desiring nationwide service, therefore, may find it most economic to combine services from either of these two suppliers with that of a Little LEO. Alternatively, a firm such as Ram Mobile Data may decide to purchase services from a Little LEO in order to fill in the gaps in its coverage and offer a nationwide service. It may even be the case that a Little LEO system will choose to buy services from firms such as Ram Mobile Data, combine them with Little LEO services, and market the final product.[12] As another example, Ardis may decide to purchase services from a Little LEO in order to fill gaps in coverage and offer a nationwide ubiquitous service. Alternatively, a Little LEO may choose to buy service from an Urban provider such as Ardis and combine the two as a final market product. Such firms are denoted in Table 1 with the addition of

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> providing coverage in geographic areas where such services are not offered or by enhancing data applications currently being provided through PSTN or the PSDN. (ORBCOMM, p.42)

and:

> The ORBCOMM system is not intended to compete with existing and planned terrestrial messaging and data systems. Rather, the Company believes that the ORBCOMM System will complement these system, which provide low- cost services primarily in metropolitan areas, where subscriber densities justify construction of radio towers. Such systems generally do no have sufficient coverage outside metropolitan areas, making them less attractive to vertical markets such as field service operations and trucking, where assets spend large portions of their operating time outside terrestrial system coverage areas. The ORBCOMM System presents an attractive complement to tower-based services because it can provide geographic gap-filler service at affordable cost without the need for additional infrastructure investment. (ORBCOMM, p. 50)

[12] Indeed, given that Little LEO systems will be global, it seems more likely that it will be the Little LEO system that will purchase more localized services to put together nationwide and global services. This seems to be particularly likely behavior for Leo One USA given its heritage in marketing and consumer service. In this, they stand in marked contrast to Orbcomm and other applicants whose heritage lie upstream at the satellite manufacturing and launch stage, and for whom their Little LEO operations may be viewed essentially as a way to foster markets for their upstream launching and satellite.

a small "c", a designation that can stand (corresponding to each of the above three scenarios, respectively) for either a complement, a customer, or a supplier. These firms are not, therefore, participants in the relevant market.[13]

Finally, as mentioned above, several of the columns refer to types of technologies (*e.g.*, broadband PCS) rather than individual suppliers (*e.g.*, Ram Mobile Data). In our analysis of the effect of the entry of Leo One USA, or any other Little LEO system, into those markets, we have assumed that the share of Little LEO systems in those markets would be small enough, and the number of competing suppliers from each of these alternative types of technologies would be large enough, that these markets would already be highly competitive. If, in addition, the services offered by Little LEO systems and by these alternative types of technologies were sufficiently homogeneous, entry by one or more Little LEO supplier(s) would not be expected to have a significant effect on prices or the welfare of consumers in those markets. As discussed below, this is clearly an over simplification and, to the extent that these assumptions are not correct, the consumer welfare gains from entry by one or more new Little LEO suppliers would be larger than those calculated below.

VI. MEASURING CONCENTRATION AND THE EFFECT OF ENTRY ON COMPETITION.

The analysis in Table 1 allows us to break down markets into three broad groups: markets where a new entrant would effectively be providing a new service, markets where a new entrant would significantly increase competition, and markets where the entry of another Little LEO supplier would be likely to have significantly lesser effects on prices paid by consumers , if any, because of the presence of low-cost (non-Little LEO) systems. The first two groups can be called "Little LEO markets", since non-Little LEO system suppliers would be unlikely to be

[13] This would be the case even if the demand for Little LEO services would be, on balance, higher if that firm disappeared. The critical question is whether, even with that firm present in the market, there exists a distinct market for Little LEO services as a complement to the services provided by the "c" firms.

present in those markets if one or more Little LEO systems were already active in those markets. *Table 3: Numbers of New-service, Other Little LEO and Competitive-niche Markets* identifies,

TABLE THREE: NUMBERS OF NEW-SERVICE, OTHER LITTLE LEO AND COMPETITIVE-NICHE MARKETS.

			New Service (NS)	Other Little Leo (OLL)	Niche - Competitive (N-C)	Total
Global	< 5 minutes		21	0	0	21
	>5&<30 min.		19	2	0	21
	>30 min.& < 3 hr.		0	20	0	20
Nationwide: Ubiquitous	< 5 minutes		21	0	0	21
	>5&<30 min.		0	0	19	19
	>30 min.& < 3 hr.		0	20	0	20
Nationwide: non-Ubiquitous	< 5 minutes		0	0	19	19
	>5&<30 min.		0	0	19	19
	>30 min.& < 3 hr.		0	0	18	18
Urban/ Pockets of Coverage	< 5 minutes		0	0	19	19
	>5&<30 min.		0	0	19	19
	>30 min.& < 3 hr.		0	0	18	18
TOTAL			80	44	112	236

by type of geographic coverage and timeliness of transmission, the number of new service Little LEO markets (designated NS), the number of other Little LEO markets with incumbent presence (designated OLL), and the number of markets where significant competition could be expected from non-Little LEO systems, with the main potential for a Little Leo system being to address

niches in these markets (designated N-C).

A. NEW SERVICES MARKETS.

Of the 236 markets identified in Table 1, 80 of those markets would not be served by any of the incumbent Little LEO systems under their current licenses. These markets are characterized by (a) a high valuation on timeliness of transmission and (b) broad (global or nationwide) geographic coverage. The only alternative non-Little LEO potential supplier in those markets will be a Big LEO System with costs significantly higher (*i.e.*, an "m" designation) than those of Leo One USA, so that, in these markets, Leo One USA will either be providing an entirely new service or will allow a large reduction in price (and/or increase in quality) to consumers. It is in these markets that the gain to consumers will be the most certain and potentially the greatest (the largest increase in consumer surplus, assuming, as appears to be the case, that the new entrant could not first-degree price discriminate) and, since these will also be the most profitable markets to enter, it is to these markets that the new entrant can be expected to first allocate its available capacity.[14]

Since the proposed Big LEO systems are the only systems that are technically capable of providing services in many of the markets that are most critical to this analysis (markets requiring global or nationwide coverage and very short outages), it is important to note that there are several considerations that are likely to severely limit the extent to which Big LEOs can be

[14] Since Little LEOs have high fixed cost (though not necessarily high sunk costs, given the relatively short life of a LEO satellite) and low marginal costs, it is important to have markets which generate net revenues that can cover all or a large part of those fixed costs, since only then can the new entrant survive vigorous competition in the other Little LEO markets where ORBCOMM or others are present. If revenue from new-service and competitive markets comes close enough to covering non-sunk fixed costs, then ORBCOMM will not be able to use strategic or predatory pricing to deter the new entrant from replacing its constellation of satellites. More generally, if the new entrant can cover much or all of its fixed costs from net revenues in these markets, it would appear more likely to "play Bertrand" (vigorously compete in price) in the other Little LEO markets.

relied upon as a competitive force in those markets.

The first consideration is the heterogeneous nature of the four proposed Big LEO systems listed in Table 2. Of the four proposed Big LEO systems, three (ICO, Iridium and Odyssey) are designated as "high cost" (h) in Table 2 on the basis of their high cost of subscriber equipment and cost of service. Only one, Globalstar, is designated as "medium" cost (hence the designation m/h for Big LEO in Table 1).[15] Thus, in contrast to markets where multiple low-cost suppliers could be expected from a single type of technology (*e.g.*, broadband PCS), competition from even a low-cost Big LEO system would at best result in a duopoly market structure in new-service markets.

Second, even if a Big LEO system faced relatively low incremental costs in serving these markets, the opportunity cost of spectrum to a Big LEO system is likely to be too high for it to compete effectively in markets served by Little LEOs. Thus, barring significantly lower demand than anticipated, or other reasons for major excess capacity among Big LEOs, even a system such as Globalstar is unlikely to find it profitable to become a significant competitor in the markets in which Little LEO systems are likely to enter.[16]

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[15] ORBCOMM's Offering Statement states that:

> The ORBCOMM System uses a packet-switched communications protocol....The Company believes this design will provide ORBCOMM with a substantial cost advantage versus the communications protocols to be used by the proposed Big LEO systems such as Iridium and Globalstar. Unlike the ORBCOMM System, Big LEO systems, which are designed primarily for two-way traffic, are required to establish a circuit-oriented connection over their network to transmit even short messages, which significantly increases the per-message transmission cost for short messages. (ORBCOMM, p.34)

[16] Information as to the true level of demand for Big LEO services is also likely to become apparent before multiple systems are launched, and perhaps even before the first is fully deployed. Since about half the cost of the system is launch costs, even a system with satellites already built could still find it profitable not to proceed if demand projections implied massive excess capacity.

Third, even if a Big LEO system faced massive capacity, so that the opportunity cost of spectrum used to compete in Little LEO markets fell to zero, the marginal cost to the consumers would remain high because the cost of subscriber equipment. Furthermore, a significant investment is required by the Big LEO to create a data product line and service it. If after launching enough of the constellation to begin offering voice service a Big LEO determined that its primary market was not adequate to create the expected return on investment it would still have to make an additional investment to enter the data product markets. Investors tolerance for additional investment at this point may be low. A data market alone is not able to support the high infrastructure costs of a Big LEO system. This additional investment would be required knowing that the rest of the constellation will probably not be launched. Customers are unlikely to invest in long term data product solutions from a Big LEO if it becomes clear that replacement satellites will not be launched after the initial constellation expires at the end of its five year life. Similarly, manufacturers will not have the confidence to invest in developing CPE.[17]

Fourth, there are significant quality differences between the service supplied by Big versus Little LEOs. As ORBCOMM points out in its August 2, 1996 Offering Memorandum:

> The ORBCOMM System has been granted FCC approval to use radio frequencies (that) are located just above those used for FM radio broadcasts and just below those used for VHF Marine push-to-talk radios. By contrast, all of the Big LEOs are currently planned to be licensed in frequencies above 1 GHz. The Company believes that the use of its allocated frequencies will provide significant advantages for packet messaging and data services compared to the use of frequencies above 1 GHz including: (1) lower power requirements to achieve acceptable link margins.....(2) better signal penetration..etc (ORBCOMM, p.36)

[17] Big LEO and Little LEO systems require completely different and incompatible subscriber equipment. Thus, Big LEO systems cannot serve Little LEO customers that already have Little LEO subscriber equipment at zero marginal cost.

Fifth (and finally), even Big LEO systems themselves do not regard Little LEOs as likely significant competitors. Although ORBCOMM was well know at the time of their Form S-1 Registration Statement filed with the SEC on November 29,1994, Globalstar's Statement makes no mention of any Little LEO. In its section on "Demand" factors, Globalstar reports that:

> Globalstar's most direct competitors are the other MSS applicants: ..Iridium..Odyssey, and Ellipso. (Globalstar, p. 15)

The Globalstar Statement also mentions two possible MEO systems, AMSC and Inmarsat, but no Little LEOs.

Similarly, Iridium's July 14, 1995 Form S-1 Registration Statement with the SEC states that:

> The Company believes that its most likely direct competition will come from one or both of the other two licensed MSS applicants ---..Globalstar,...Odyssey...and the planned Inmarsat-P telecommunications service. It is also possible that the Company could face competition in the future from the MSS applicants that did not receive FCC licenses in January 1995 -- Constellation,..MCHI,...and AMSC, and from systems proposed by Teledesic,...Hughes,....and Cyberstar. (Iridium, p. 57)

B. HIGHLY CONCENTRATED (OR MONOPOLY) "OTHER LITTLE-LEO"MARKETS

In another 44 markets, one or more incumbent Little LEO systems, as licensed, would be the low-cost provider(s). In these "other Little LEO markets," new entry would result in a significant decrease in concentration and could be expected to lead to significant price decreases and thus benefits to consumers. Estimates of the amount of the gain to consumers in these markets would depend on the oligopoly model assumed and on the size of the decrease in concentration, which in turn is highly sensitive to the various licensing alternatives under

consideration by or proposed to the FCC. The expected effect on prices and on consumers from new entry would also depend significantly on how VITA could be expected to operate, and on the likelihood that the GE Starsys system will be implemented.

Table 4: HHI analysis calculates the HHI in these "other Little LEO markets" under combinations of four potential licensing outcomes and four potential combinations of roles for GE Starsys and VITA. The first column assumes that Orbcomm, GE Starsys and VITA each fully deploy their licensed systems, and all compete in these markets. Capacity of each system is measured in "current Orbcomm equivalent units," and the HHI is calculated as the sum of the squares of the percentage shares of total capacity assigned to each system. The first row assumes capacity equal to current licensed capacity, with three suppliers, a total capacity of 1.31 "units", and an HHI of 6239. The second row assumes that no new licensing occurs, and Orbcomm's second round amendment is accepted, increasing Orbcomm's capacity to 1.16 units, total capacity to 1.47 units, and the HHI to 6558. The third row assumes that three additional licenses are awarded as proposed in Systems 1, 2, and 3 by the NPRM, resulting in an increase in total capacity to 2.36 units and a decrease in the HHI to 3175. Finally, the fourth row assumes that two additional licenses are awarded for System A and B as proposed by Leo One, resulting in a increase in total capacity to 3.13 units and a further fall in the HHI to 2784.

The second column recalculates the system capacities and HHIs under the assumption that VITA would not compete with other Little LEO suppliers in these markets, but would instead concentrate its efforts in specialized markets which for-profit firms would be unlikely to wish to enter, especially in competition with a non-profit supplier. Column three assumes that GE Starsys fails to launch its system, exits, or otherwise fails to compete effectively and survive

TABLE 4: HHI Analysis

Potential Licensing Outcomes

1 Today's environment

Licensee	Orbcomm, Starsys & VITA each fully deploy licensed systems			VITA operates in specialized non-for-profit market			Starsys fails to launch its system			Neither VITA or Starsys participate in the market		
	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI
Orbcomm	1	76.51%	5854	1	80.00%	6400	1	94.61%	8951	1	100.00%	10000
Starsys	0.25	19.13%	366	0.25	20.00%	400	0	0.00%	0		0.00%	0
VITA	0.057	4.36%	19	0	0.00%	0	0.057	5.39%	29		0.00%	0
	1.31		6239	1.25		6800	1.06		8980	1.00		10000
Market Concentration			6239	Market Concentration		6800	Market Concentration		8980	Market Concentration		10000

2 No new licensing, Orbcomm 2nd round ammendment is accepted.

Licensee	Orbcomm, Starsys & VITA each fully deploy licensed systems			VITA operates in specialized non-for-profit market			Starsys fails to launch its system			Neither VITA or Starsys participate in the market		
	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI
Orbcomm	1.16	79.07%	6253	1.16	82.27%	6768	1.16	95.32%	9085	1.16	100.00%	10000
Starsys	0.25	17.04%	290	0.25	17.73%	314	0	0.00%	0		0.00%	0
VITA	0.057	3.89%	15	0	0.00%	0	0.057	4.68%	22		0.00%	0
	1.47		6558	1.41		7083	1.22		9107	1.16		10000
Market Concentration			6558	Market Concentration		7083	Market Concentration		9107	Market Concentration		10000

3 Three additional licenses awarded as proposed in Systems 1, 2, & 3 by the NPRM.

Licensee	Orbcomm, Starsys & VITA each fully deploy licensed systems			VITA operates in specialized non-for-profit market			Starsys fails to launch its system			Neither VITA or Starsys participate in the market		
	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI
Orbcomm	1	42.30%	1789	1	43.35%	1879	1	47.30%	2238	1	48.61%	2363
Starsys	0.25	10.58%	112	0.25	10.84%	117		0.00%	0		0.00%	0
VITA	0.057	2.41%	6		0.00%	0	0.057	2.70%	7		0.00%	0
System 1	0.057	2.41%	6	0.057	2.47%	6	0.057	2.70%	7	0.057	2.77%	8
System 2	0.84	35.53%	1263	0.84	36.41%	1326	0.84	39.74%	1579	0.84	40.84%	1668
System 3	0.16	6.77%	46	0.16	6.94%	48	0.16	7.57%	57	0.16	7.78%	61
	2.36		3175	2.31		3328	2.11		3831	2.06		4039
Market Concentration			3175	Market Concentration		3328	Market Concentration		3831	Market Concentration		4039

4 Two additional licenses awarded as proposed in System A & B by *Leo One USA*.

Licensee	Orbcomm, Starsys & VITA each fully deploy licensed systems			VITA operates in specialized non-for-profit market			Starsys fails to launch its system			Neither VITA or Starsys participate in the market		
	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI	Capacity	Market Share	HHI
Orbcomm	1	31.98%	1023	1	32.57%	1061	1	34.76%	1208	1	35.46%	1257
Starsys	0.25	7.99%	64	0.25	8.14%	66		0.00%	0		0.00%	0
VITA	0.057	1.82%	3		0.00%	0	0.057	1.98%	4		0.00%	0
System A	0.9	28.78%	828	0.9	29.32%	859	0.9	31.28%	979	0.9	31.91%	1019
System B	0.92	29.42%	866	0.92	29.97%	898	0.92	31.98%	1023	0.92	32.62%	1064
	3.13		2784	3.07		2885	2.88		3213	2.82		3340
Market Concentration			2784	Market Concentration		2885	Market Concentration		3213	Market Concentration		3340

in these markets.[18] Finally column four assumes that neither VITA nor GE Starsys are effective competitors in these markets.

As Table 4 shows, even assuming that the GE Starsys system will be viable and that VITA competes with the for-profit systems, these markets would already be highly concentrated with only first round licensees, with an HHI (the Herfindahl-Hirschman Index calculated from capacity-based shares, which is the preferred measure of concentration where differentiation -- within each of the 44 markets -- is slight) of at least 6239. If the remaining NVNG MSS capacity were assigned to first round licensees (or, equivalently, if first round licensees were allowed to compete in an auction) the HHI in these markets would rise to at least 6558 (an increase of 5%). In contrast, if two additional licenses for efficiently configured and sized systems are assigned to new entrants, as proposed by Leo One USA, the HHI would fall significantly, to at least 2784 (a decrease of 53%). Under a less optimistic set of assumptions (*i.e.*, VITA operates in a specialized not-for-profit market, and GE Starsys fails to launch its system) the HHI in these markets will remain at 10,000 if the available remaining capacity were assigned to ORBCOMM (or, equivalently, if ORBCOMM were allowed to compete in an auction), and would fall to 3340 (a decline of 67%) if, as proposed by Leo One USA, two additional licenses for efficiently configured and sized spectrum are allocated to entrants. While the effects of changes in concentration on prices depends on a number of factors, the significance of these changes in the

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[18] The potential limitations of GE Starsys as an effective competitor are noted in Orbcomm's Offering Memorandum:

> Starsys employs code division multiple access ("CDMA") modulation (spread spectrum) that must operate in spectrum that is allocated on both a "primary" and "secondary" basis to Little LEO services. As a result, Starsys will operate at lower power levels to avoid interference to other services. The low power rate results in a maximum transmission rate of 600 bps from Subscriber Communications compared with 2,400 bps for the ORBCOMM System. In addition, the U.S. Government has imposed a channel occupancy limit on Starsys of 25% of that permitted for the ORBCOMM System to prevent interference to existing U.S.Government systems. The Company believes that no operational Starsys satellites will be launched until 1997 at the earliest, and that completion of the network will not be accomplished before 2000. (ORBCOMM, p.49)

HHI can be seen by observing that, under a widely used oligopoly model in industrial organization (the Cournot model), percentage price changes would, because of the very high share of fixed costs in this industry, be close to the percentage changes in the HHI.[19]

In markets where the incumbent would be a monopolist, new entry could be expected to result in a very large price decrease, with the amount depending on the oligopoly model or "game" (collusion, Cournot, Bertrand) assumed or expected, and the relative capacities of the two firms. Only if the incumbent and the new entrant would collude perfectly -- a highly unrealistic assumption -- would there be no gain to consumers. At the other extreme, if the incumbent and the new entrant "played Bertrand" (competition in prices), then the price would fall to marginal cost, generating a very large increase in consumer surplus. An intermediate result would be expected if the incumbent and the new entrant were equally sized and "played Cournot" (competition in quantities), in which case price could fall by one third.[20]

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[19] These HHI levels and differences would clearly violate the *Guidelines* if this were a merger. In other words, if the spectrum were granted to Leo One USA, the FTC or DOJ could be expected to attempt to block any subsequent merger between Leo One USA and either ORBCOMM or GE Starsys, at least absent a failing company defense or a showing of overpowering efficiencies unique to the merger. Under the *Guidelines*:

> Mergers producing an increase in the HHI of more than 50 points in highly concentrated markets (HHI >1800) post-merger potentially raise significant competitive concerns...Where the post-merger HHI exceeds 1800, it will be presumed that mergers producing an increase in the HHI of more than 100 points are likely to create or enhance market power or facilitate its exercise.(*Guidelines*, pp 30-31).

[20] In a Cournot market with linear demand and constant marginal cost, the market price, as a proportion of the monopoly price, is given by (for a derivation, see Dennis W. Carlton and Jeffrey M. Perloff, *Modern Industrial Organization*, Scott, Foresman, 1990, p.267):

$$P\text{-}MC = 2/(N+1)$$

where:

P = market price in a Cournot market,
MC = marginal cost, and
N = number of equal sized suppliers

which, in an industry with zero marginal cost, reduces to:

$$P = 2/(N+1)$$

In markets where the market structure from the first processing round would be a duopoly, the price decrease following entry could also be quite large, but under different conditions. Now, if the incumbent duopolists played Bertrand, the price decrease would be zero, since the current duopoly price would already be the competitive price. Similarly, if the incumbent duopolists colluded and all three firms continued to collude after entry, price would remain at the monopoly level, and the price decrease would be zero. At the other extreme, if two Little LEOs would collude (perhaps by allocating markets and not entering into each other's assigned markets), but collusion would break down completely with a third supplier, prices could fall to marginal cost, generating very large gains to consumers. Again, an intermediate result would be expected if all suppliers play Cournot, with substantial gains to consumers since the HHI would fall significantly: moving from two to three equal sized competitors, for example, would result in a further 25% fall in price.

C. RELATIVELY COMPETITIVE NICHE MARKETS.

In the remaining 112 markets identified, Little LEO systems would face effective competition from other multiple suppliers of several types of systems, notably cellular, broadband PCS and SMR, as well as terrestrial data system suppliers such as Cellnet and CDPD. Entry of second round licensees into these markets can thus be expected to be the lowest priority use for their available capacity, as well as affecting prices the least and generating the lowest

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Thus, in such a market, a market with one supplier would have a price of 1.0; a market with two suppliers would have a price of 2/3 (so that the entry of the second firm would result in a 33% price decrease); a market with three firms would have a price of ½ (so that the entry of the third firm would result in a further 25% price decrease), etc.

This relationship can be expressed in terms of the HHI by defining the "numbers equivalents" as:

$$N^* = 10{,}000/HHI$$

so that the market price, as a proportion of the monopoly price, can be restated as:

$$P\text{-}MC = 2\ HHI\ /(HHI + 1)$$

which, in an industry with zero marginal cost, reduces to:

$$P = 2\ HHI\ /\ (HHI + 10{,}000)$$

For an application of this approach, see Section VII, below.

amount of benefit to consumers.

Even though existing and proposed terrestrial data networks would provide effective competition for Little LEO systems in urban areas, it is possible that purchasers of services in those areas may select Little LEO systems for service. For example, Company A provides vending machine services in 20 markets throughout the southeast. The Company decides to contract with a wireless data service provider to monitor the Company's machines for product outages and mechanical status. While each market has multiple wireless data providers, no single provider offers service in all 20 markets. Company A may prefer to subscribe to services from a Little LEO provider that can provide connectivity to the vending machines in all 20 markets, thus increasing the efficiency of the company's back office operations.

D. REVENUE SHARES FROM NEW-SERVICE, LITTLE LEO, AND COMPETITIVE MARKETS.

Given that any new entrant can be expected to allocate system capacity into its most profitable use, it is not surprising that Leo One's revenues are expected to come disproportionately from new-service and Little LEO markets. As *Table 5: Expected Leo One USA Revenue Distribution Across New-Service, Other Little LEO and Competitive-Niche Markets* shows, new-service markets account for 32% of the number of markets but are expected to generate 60% of revenue. Little LEO markets account for 17% of the number of markets, but are expected to generate 26% of revenues. And competitive markets, which account for 44% of the number of potential markets, are expected to account for only 14% of Leo One USA's revenues.

SECTION VII: THE EFFECT OF ENTRY AND CHANGES IN CONCENTRATION ON PRICES AND ON THE WELFARE OF CONSUMERS

TABLE 5: LEO ONE EXPECTED REVENUE, YEAR 5, BY MARKET

Market Analysis Summary

$ Revenue (millions)

	Tracking	Monitoring	Emergency Services	Messaging	Transaction Services	Total	% of Total
"NS" Markets	151.1	10.2	40.3	92.9	0.8	295.3	60%
"OLL" Markets	64.8	21.4	0.0	39.8	0.0	125.9	26%
"N-C" Markets	36.5	8.9	7.0	14.7	0.1	67.2	14%
Total	252.4	40.5	47.3	147.4	0.9	488.5	100%

These data, when combined with some simple but not unrealistic -- even conservative -- assumptions, are sufficient for us to derive a rough, "back of the envelope" estimate of the gain to consumers (the increase in consumer surplus) that would result from the entry of Leo One USA's proposed System A and System B. For example, assuming linear demand curves in all markets; all costs fixed (*i.e.*, zero marginal cost); Cournot-type behavior in oligopoly markets; VITA competing in for-profit markets and GE Starsys successfully launching its system; the entry of Leo One USA and a second new entrant; only one new entrant entering into "new service" markets; and no effect at all on prices in "competitive-niche" markets from the System A or the System B supplier's entry into those markets, the estimated increase in consumer surplus in year five from new entry would be 50% of Leo One USA's anticipated year-five revenue of $ 295 million from new service markets and approximately 236% of Leo One USA's year-five anticipated revenue of $126 million from "Other Little Leo" markets, plus 0% of Leo One USA's anticipated revenue of $ 67 million from "competitive-niche" markets, for a total increase in consumer surplus of $ 444 million, or 91% of Leo One USA's anticipated total revenue.

This derivation is shown in *Table 6: Effect of Leo One Proposal on Consumer Surplus* and is illustrated in *Figure 1: New-Service Markets*, *Figure 2: Other Little LEO Markets* and *Figure 3: Competitive-Niche Markets*. Table 6 begins, for three situations (new service markets after entry, other Little LEO markets before entry, and other Little LEO markets after entry) with the HHI in that market (see Table 4), calculates the number equivalent (N), and determines the quantity (Q), market price (P) and amount of consumer surplus (CS) in that market, assuming linear demand and zero marginal costs.[21] Assuming market shares for System A of 100% in new-service markets and 29% in other Little LEO markets (System A's share of capacity from Table 4), and using the estimates of Leo One's expected revenue in five years (from Table 5), we can derive the expected level of consumer surplus in these three markets in year 5. The total

[21] See footnote above. For the derivation of the formulas in Table 6, see Carlton and Perloff (1990), p.267

TABLE 6: EFFECT OF LEO ONE PROPOSAL ON CONSUMER SURPLUS

	HHI	N	Q	P	CS	Rev Leo	Ratio, CS to Rev. Leo1	Leo1 Rev. in Year 5	CS in Year 5
New Service Market	10,000	1.00	1.00	1.00	0.50	1.00	0.50	295	148
OLL Market, current	6239	1.60	1.23	0.77	0.76	0.00	0.00	0	484
OLL Market, Leo 1 Proposal	2784	3.59	1.56	0.44	1.22	0.20	6.19	126	780
LL Market, Leo One Proposal minus OLL Market, current	-3455	1.99	0.33	-0.33	0.47				297
Total CS Increase Leo1 from current									444

N = 10,000/HHI

Q = 2N/(NH)

P = 2/(N+1)

$CS = 2N^2/(N+1)^2$

Rev Leo 1 = (Market Share Leo 1) PQ
MS Leo 1: Current = 0
MS: Leo 1: Leo One Proposal = 0.29
(from Table 4)

increase in consumer surplus from entry ($ 444 million) is then equal to the consumer surplus in new-service markets ($ 148 million) plus the difference between the pre-entry and post-entry consumer surplus in other Little LEO markets ($ 297 million).

Figures 1-3 illustrate the effect of entry in the three market types: new service, other little LEO, and niche- competitive. Figure 1 illustrates the effect of entry by one new provider into a new service market with a linear demand curve and zero marginal cost. Under these assumptions, quantity (Qns) is one half the quantity that would be demanded if price (Pns) equaled marginal cost, so that the increase in consumer surplus because of the availability of this service (area abc in Figure 1) would be equal to one half of the revenue expected from its provider (area bcde in Figure 1).

Figure 2 illustrates the effect of entry (by the System A and the System B suppliers) in an "other Little LEO market". Assuming linear demand curves and zero marginal cost, a reduction in the HHI from 6239 to 2784, and a market share of System A equal to its 28% share of capacity, the entry of System A and System B would result in an increase in consumer surplus (area abcde in Figure 2) equal to 2.36 times the revenue expected by Leo One USA (area defg in Figure 2).

Finally, Figure 3 illustrates the effect of entry (by System A and System B) into a perfectly competitive market, into which Little LEO suppliers essentially allocated whatever capacity would be left over after serving "Little LEO" markets. While Little LEO systems may make profits (or quasi-rents) in these markets, under these assumptions there would be no increase in consumer surplus from entry into these markets. Of course, to the extent that Little LEO sales in these markets were better characterized as sales of a differentiated product into "niche markets," there could be significant consumer gains from Little LEO entry into these markets, of the same proportion of expected Leo One USA revenues in those markets as for new-service or "other Little LEO" markets.

Figure 1: New Service Market

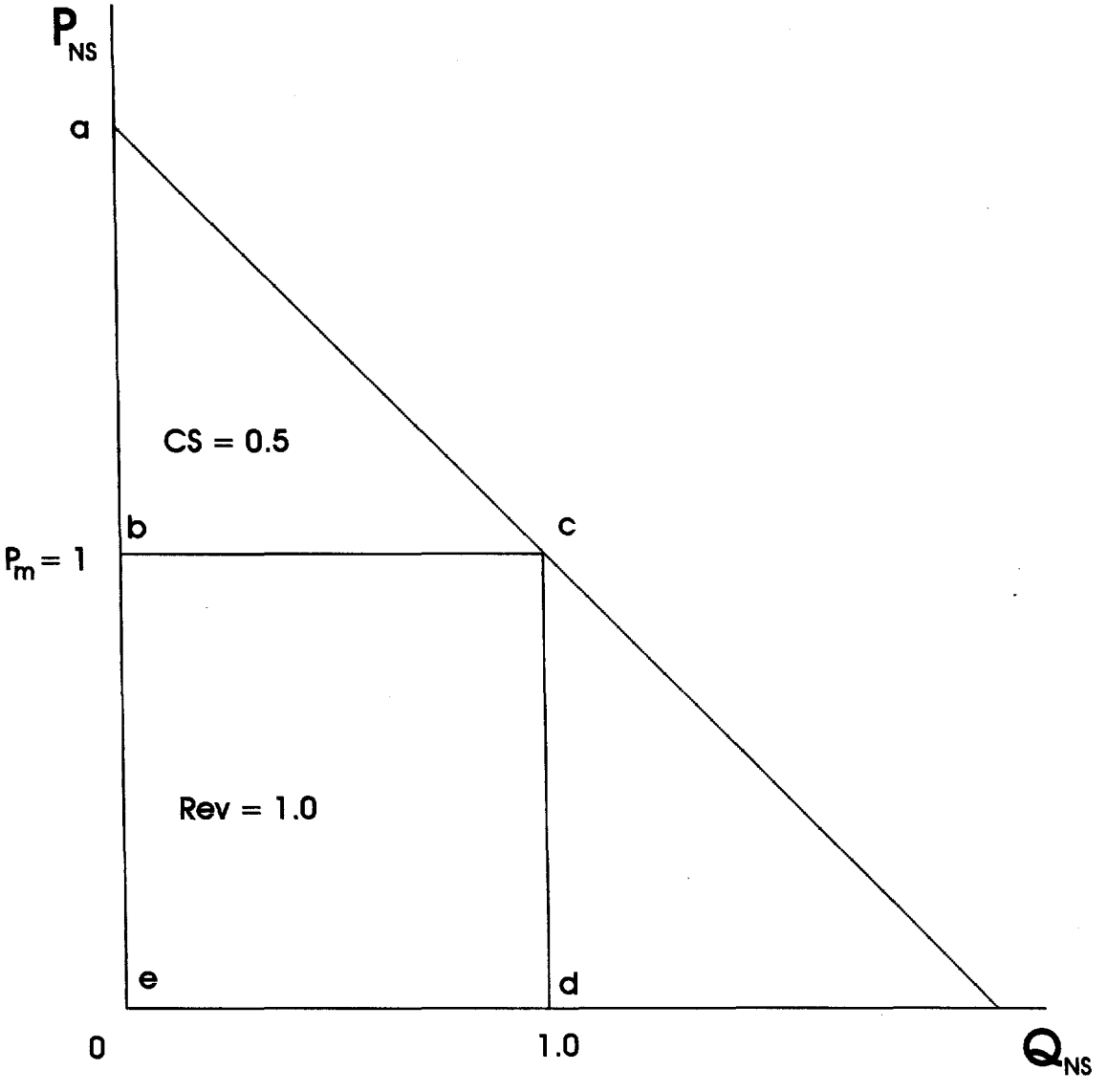


Figure 2: Other Little Leo Market

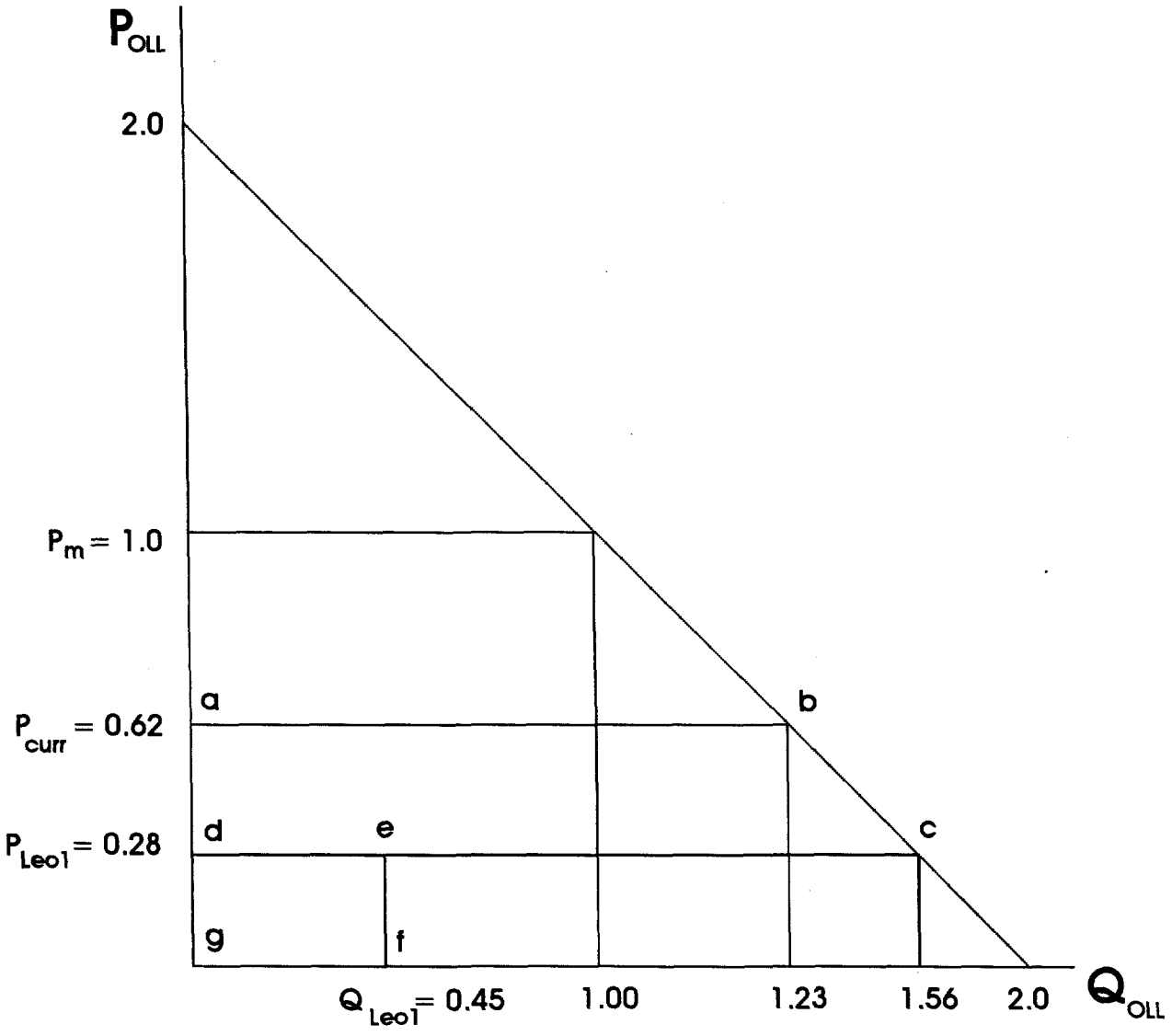
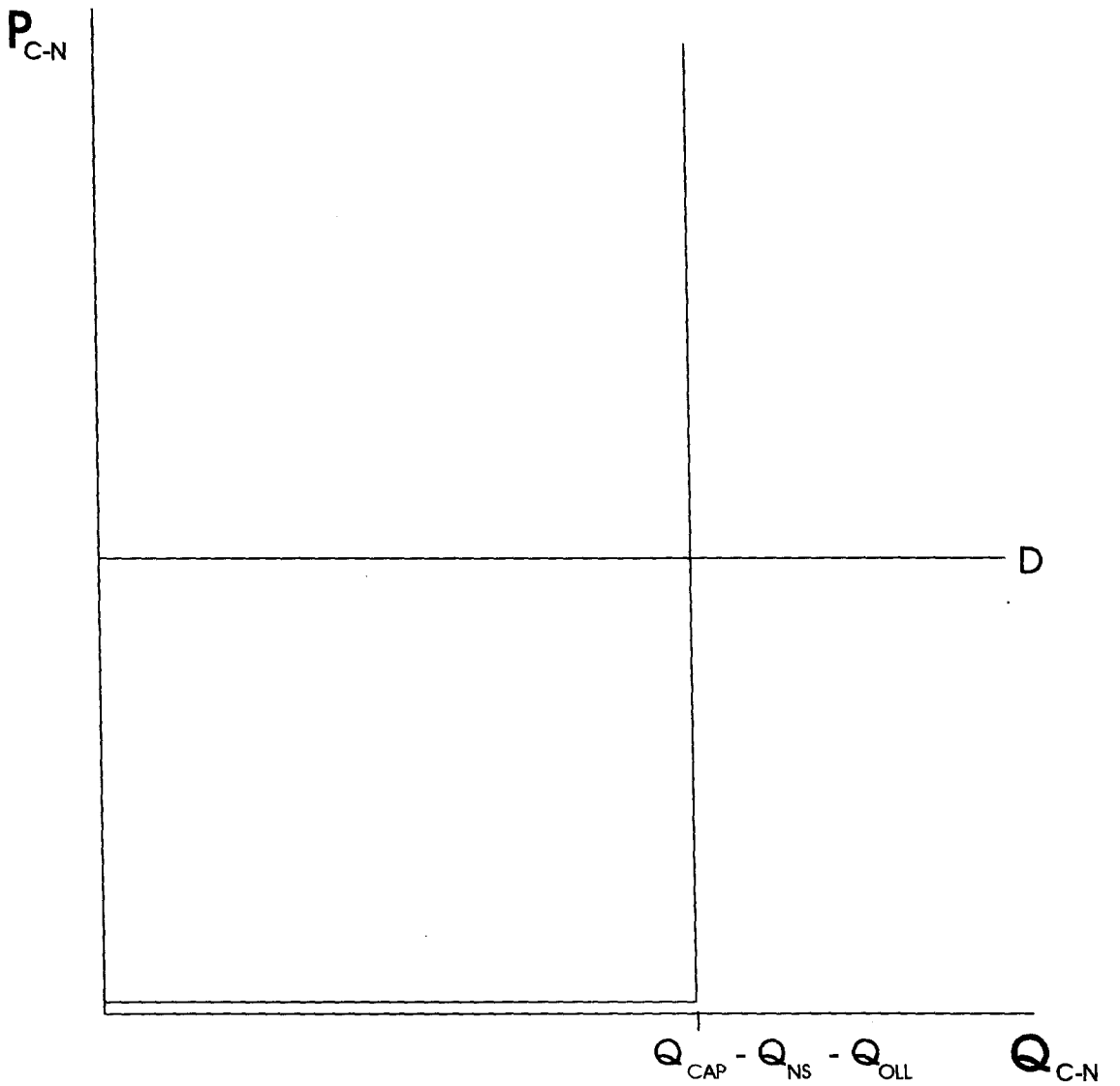


Figure 3: Competition - Niche Market



SECTION VIII: *INCUMBENT INCENTIVES IF SPECTRUM IS ALLOCATED THROUGH AN AUCTION*

Incumbent firms with market power have anticompetitive incentives to request spectrum or to bid on spectrum if an auction is held. In this case, ORBCOMM (and potentially GE Starsys) has an incentive to acquire spectrum to block entry into markets in which it expects to operate or plans to enter eventually. Either or both could find it profitable to bid significant amounts (especially if ORBCOMM and GE Starsys act together or split the cost) even if they planned simply to warehouse that capacity. Since total profits of all suppliers would fall with entry, the monopolist (or duopolists) stand to lose more than the entrant will gain, so that a monopolist (or duopolists acting together) will always outbid an entrant. Or, as phrased in the leading graduate industrial organization text[22]:

> Because competition destroys industry profits, an incumbent has more incentive to deter entry than an entrant has to enter. (Tirole, 1980, p.350)

This is particularly true in this situation because, since marginal costs are very low, entry could be very expensive to the incumbent(s). Thus, an unrestricted auction could be expected to result in maintenance of the current, noncompetitive market structure, and a waste of the spectrum.

On the other hand, it might be argued that restricting any auction to new entrants could reduce the revenue received by the government for a scarce publicly-owned resource. We thus turn to a discussion of the potential benefits and potential costs of restricting any auction to new entrants.

A.. THE BENEFITS FROM RESTRICTING PARTICIPATION IN AN AUCTION TO NEW

[22] Jean Tirole, *The Theory of Industrial Organization*, The MIT Press, 1988.

ENTRANTS.

Incumbent monopolists have incentives to outbid potential entrants for any scarce resources necessary to enter and compete. When they do so, this is referred to as "preemption."

Curtis and Lipsey (1979), Dasgupta and Stiglitz (1980), Gilbert and Newberry (1982) and Krishna (1993)[23] -- among others -- were instrumental in clarifying the intuition behind preemption. And the intuition is simple: the most an entrant can bid for a scarce resource (e.g., a necessary government license or an oil reserve) is the profit an entrant earns in a duopoly market. The scarce resource is worth more to an incumbent monopolist, since by winning the bid for the resource, the monopoly profit stream can be retained. Since (absent perfect collusion) monopoly profits exceed duopoly profits, monopoly profits also exceed the entrant's share of duopoly profits. As Lewis (1983) described the analysis:

> [The] argument is simple and appealing. Suppose the market can accommodate one more firm. The leader can prevent entry by spending more than the potential entrant to acquire the input necessary for production. The value of the input to the entrant equals the expected present value stream of its profits. This will be determined by competition with the leader which may take several forms. However, unless the post-entry equilibrium is cooperative, the input will be worth more to the dominant firm. The reason is that the leader can at least utilize the input exactly as the entrant would have used it...but

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[23]See Curtis Eaton and Richard Lipsey, "The Theory of Market Preemption: The Persistence of Excess Capacity and Monopoly in Growing Spatial Markets," *Economica*, May 1979, pp. 149-58; Partha Dasgupta and Joseph Stiglitz, "Uncertainty, Industrial Structure, and the Speed of R&D," *Bell Journal of Economics*, Spring 1980, pp. 1-28; Richard Gilbert and David Newberry, "Preemptive Patenting and the Persistence of Monopoly," *American Economic Review*, June 1982, pp. 514-26; Tracy R. Lewis, "Preemption, Divestiture, and Forward Contracting in a Market Dominated by a Single Firm," *American Economic Review*, December 1983, pp. 1091-1101, and Kala Krishna, "Auctions With Endogenous Valuations: The Persistence of Monopoly Revisited," *American Economic Review*, March 1993, pp. 147-160.